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MINERALOGY.—*Calcite oolites with pentagonal dodecahedral form.*[1]

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The present paper contains a description of some very unusual forms of calcite oolites from Idaho and Japan. The Idaho specimens are from the collection of the late Frederick A. Canfield and those from Japan are in the reference collection of the National Museum. These oolites are regular pentagonal dodecahedra, a geometrical form impossible as a crystal form. It is suggested that they owe their peculiarity to pentagonal dodecahedral packing of the oolites in their original resting place.

The Idaho material (Canfield No. 5801) is labeled "Calcite, Eagle Rock, Idaho; these forms are regular pentagonal dodecahedrons—said to be impossible for crystals. Presented by Dr. F. M. Endlich, who collected them. See Dana page 268." On page 268 of the sixth edition of Dana's *System of Mineralogy* the following reference to the material from this locality appears: "Minute concretionary forms having a spherical concentric structure within and externally the form of a regular pentagonal dodecahedron (not pyritohedron) have been obtained from a calcareous spring near Eagle Rock, Idaho; their form has not been explained." The information given by Dana was doubtless obtained from examination of the same material as that in the Canfield collection, since no reference to these forms has been found elsewhere in the literature. Nothing definite has been learned relative to the occurrence. Eagle Rock is not given on any map or in any gazeteer which has been examined. The specimens were collected by F. M. Endlich, apparently while engaged in work on the Hayden Survey, probably about 1872. In several places in the re-

[1] Published by permission of the Acting Secretary of the Smithsonian Institution. Received August 31, 1927.

port for that year mention is made of Eagle Rock or Taylor's Bridge across Snake River, apparently northwest of Ross Fork and probably at or near the site of the present bridge south of Tilden and east of Yuma. There is no mention of the calcite oolites or of any calcareous spring.[2]

The Canfield material consists of a dozen white and porcellanous-appearing individuals 2 millimeters in diameter. They are almost model pentagonal dodecahedra although the edges are somewhat rounded and some of the faces are curved. They possess sufficient luster to cause most of the faces to yield a visible though faint signal on the goniometer, and the majority of the faces fall in the positions of the planes of the geometric form. Although they naturally suggest pyritohedra to the mineralogist, the edges are all of equal length and the interfacial angles are all the same.

One broken individual was crushed and examined under the microscope. The structure is distinctly concretionary and very finely fibrous spherulitic. The natural tendency to break parallel to the fibrous structure competes with a parting in thin skins parallel to the spherical surface. The spherical flakes are approximately perpendicular to the optic axis of a majority of the aggregated fibers and are largely dark between crossed nicols, but are granular with stippling by grains of higher birefringence. The flakes as a whole give an apparent interference figure which is uniaxial or slightly biaxial with 2E nearly zero and with positive sign. Calcite is optically negative and it would seem that this positive interference figure is anomalous and is due to the fibrous structure—a supposition strengthened by the features of the grains which lie parallel to the fibers showing maximum birefringence, for the elongation of these fibers is negative, and thus contradicts the observed positive interference figure. Measurements of the refractive indices were not satisfactory. Basal flakes yielded for ω the apparent value 1.655, and prismatic flakes gave for ϵ a value considerably above 1.485. The apparent birefringence is thus somewhat lower than that of calcite, but this is doubtless another anomaly due to the structure. No grain large enough to examine was crystallographically a single unit but each was made of an enormous number of individual fibers, only a majority of which were in a position to show the ultimate indices. Where the birefringence is very high, as in calcite, and the material fine grained, a relatively small dilution of the extreme values for the indices by fibers away

[2] F. H. BRADLEY, *The Snake River Division.* U. S. Geol. Geogr. Survey Terr. (Hayden), 6th Ann. Rept., p. 209. 1873.

from the critical position must effect a considerable change in the mass index.

Lacroix[3] has given the name "ktypeite" to pisolitic material from Carlsbad, Bohemia, and Hammam-Meskoutine, Algeria, formerly referred to aragonite and similar in character to the oolites from Idaho. Its specific gravity was given as varying from 2.58 to 2.70, or less than that of calcite. Its birefringence was found to be 0.020 while that of calcite is 0.172. In parallel polarized light a black distorted cross was noted, while portions gave a positive black cross in convergent light. Heated to low redness the pisolites decrepitated and finally were "transformed into calcite." "Ktypeite" is quite probably the same as the material here described and owes its apparent deviation from the optical properties of calcite to the intimately fibrous concretionary structure, the relation to calcite being similar to that of chalcedony to quartz.

The most striking and unexplainable feature of the Idaho material being the geometrical form, a search was made through the various collections of the National Museum for other examples of oolites or pisolites exhibiting similar features. The only other samples found (U. S. N. M. Cat. Nos. 47,123 and 86,694) were from Shinano Province, Japan. These consist of some hundreds of pisolites varying from 2 millimeters to 15 millimeters in diameter. The smaller of these are spherical or ellipsoidal in form, and the larger are subangular. Two of the subangular specimens about 10 millimeters in diameter are well defined pentagonal dodecahedra with rounded edges and concave faces.

In an attempt to determine whether the oolites under discussion are aragonite or calcite three of the small spheres from Japan, one of the larger Japanese dodecahedra, three snowy-white and perfectly spherical oolites 2 millimeters in diameter from the "Snake River Hot Springs," Montana, (U. S. N. M. Cat. No. 45,998), one of the Idaho dodecahedra, and a small fragment of "flos ferri" aragonite from Steiermark, Austria, (U. S. N. M. Cat. No. 87,304), were boiled together in dilute cobalt nitrate solution. The dodecahedra from both Idaho and Japan and the spherical oolites from Japan took on the pale blue color of calcite while the "flos ferri" and the Montana oolites showed the deep violet characteristic of aragonite. It seems established that the polyhedral oolites under discussion are calcite.

The writer is informed by Mr. Laurence La Forge that Wirt Tassin

[3] A. LACROIX, Acad. sci. C. R. **126**: 602. 1898. See DANA, *Syst. Min.*, 6th ed., App. 1, p. 39. 1899.

found polyhedral oolites in the collections of the Hayden Survey and, after engaging in considerable speculation as to the origin of the unique forms, analyzed them and found them to be pure calcium carbonate. No record of the figures of this analysis can be found nor any of the analyzed sample. The present writer found the material to dissolve completely in cold dilute hydrochloric acid.

The internal structure of the dodecahedral forms is that characteristic of radiate-fibrous concretionary oolites—a structure that almost invariably produces a more or less spherical form. Thus the symmetry of the exterior of the oolites cannot be the result of internal structure or forces, and it becomes pertinent to inquire as to what external conditions may have produced the polyhedral forms. The normal explanation in mineralogy for external geometric symmetry which is at variance with internal molecular structure is either pseudomorphism or inversion. In pseudomorphism a previously existing crystal with euhedral boundaries has been converted into another substance by chemical reaction without a change in form. The molecular structure of the second substance bears no relation to the external geometric form inherited from the preceding mineral. In the present case the crystal-like forms are pentagonal dodecahedra, represented in crystallography only by the pyritohedron, so named because it is of frequent occurrence with the minerals of the pyrite group. It is a solid bounded by twelve faces, each of which is a pentagon with four equal sides and one longer side, and closely resembles the regular pentagonal dodecahedron of geometry with regular pentagons as faces. The regular pentagonal dodecahedron is one of the two regular solids of geometry which are impossible in crystallography because they are contrary to the laws of symmetry and rational indices. The ratios of the axial intercepts of a crystal face must be either whole numbers, zero, or infinity, whereas the intercepts of the face of the regular pentagonal dodecahedron in prismatic position are as $1:\frac{1+\sqrt{5}}{2}:0$. The only possible explanation of the origin of the calcite forms in question by pseudomorphism is to assume that they have replaced pyrite crystals bounded by a pyritohedron of high and irrational indices closely approaching the regular pentagonal dodecahedron in angle—an assumption which is highly improbable.

The other cause of lack of correspondence between external crystal form and internal structure, inversion, is illustrated by many minerals of which leucite is a typical example. This mineral, which occurs as isometric trapezohedral crystals of perfect form, is usually biaxial in

polarized light under the petrographic microscope and has the properties of a doubly refracting substance. The accepted explanation of this discordance between form and internal structure is that the substance at an elevated temperature has the symmetry represented by the external form, but at ordinary temperatures possesses the symmetry represented by the internal structure. The mineral was formed at high temperature and the external form was determined by that temperature. The internal structure, however, inverted in cooling to that stable at ordinary temperatures. In the case of calcium carbonate there is no high temperature form which approaches isometric symmetry and inversion therefore cannot be invoked as the cause of the form of the unusual oolites.

Since the pentagonal dodecahedral forms cannot be logically explained by changes in internal structure or by pseudomorphism it seems reasonable to investigate the possibility that they are due to forces operating externally. Oolites structurally like those under consideration and more or less spherical in form are frequently formed in calcareous springs and the most perfectly rounded ones are those which are kept more or less continuously in suspension by the rising current of water. Since the Idaho examples are typical oolites structurally, and were formed in a calcareous spring, there is sufficient reason for assuming that they were originally spherical and that the spherical form was subsequently modified by external forces. The most probable force to be considered is the result of mutual interference or crowding and the problem becomes that of the mutual deformation of spheres. If it be assumed that spherical oolites of uniform size and perfect form settled in recesses of the spring and continued to grow at a uniform rate, they must ultimately have reached the point where the surfaces of contact were practically plane. Compression of closely packed plastic spheres would give the same result, were the pressure essentially equal from all directions, but the calcite spherulites are essentially rigid and their deformation can scarcely be attributed to pressure from outside the mass of oolites. It is doubtless due to continued growth by accretion from the calcium carbonate of the spring water.

The natural supposition would be that when uniform spheres have been so modified as to fill space solidly by becoming plane surfaced, polyhedra, each polyhedron would be a geometric holohedron and the problem presented for solution would be the classic one of the division of space with minimum partitional area. Were only two dimensions represented the problem would be easily solvable and the solution

capable of facile experimental demonstration. Thus a single layer of uniform spheres is easily seen to assume a hexagonal packing and the ideal deformation of cylinders into hexagonal prisms, as classically represented in honeycomb textures, is illustrated by many natural examples. In three dimensional packing the problem is not so simple. The mathematical solution derived as to the angles for stable equilibrium is simply that every angle of meeting of film-surfaces is exactly 120°.[4] The rhombic dodecahedron is a polyhedron of plane sides between which every angle of meeting is 120°. Space can be filled with or divided into equal and similar rhombic dodecahedrons and the rhombic dodecahedron might seem to be the solution of the problem for the case of cells equal in volume and having every part of the boundary of the group either infinitely distant from the place considered or so adjusted as not to interfere with the homogeneous interior distribution of the cells. The rhombic dodecahedron is the only plane-sided polyhedron which presents a solution of the equilibrium problem. Lord Kelvin concluded from theoretical considerations, however, that, as found by Plateau by experimentation with soap films, the angles of the rhombic dodecahedron, giving when space is divided into such figures twelve plane faces meeting at a point, are essentially unstable. He concluded that the requirements of stability are best fulfilled when the rhombic dodecahedron is so divided by insertion of planes that the unit becomes what he calls a minimal tetrakaidecahedron or an isotropic tetrakaidecahedron, familiar to crystallographers as a cuboctahedron, having curved arcs of 19° 28′ for its edges.

Desch[5] has critically considered this problem from the standpoint of the metallurgist with the view of determining and explaining the forms of the crystal grains in solidified metals. According to the hypothesis of Quincke, metals and other substances, immediately before solidification from the liquid state, separate into two immiscible liquids, one in much smaller quantity than the other. These liquids have interfacial surface tension and a foam is formed, the liquid present in smaller proportion arranging itself in cell walls and the other constituting the cell contents. Crystallization then takes place within the cells and the cell walls are represented in the solid mass by the boundaries of the crystal grains. If this hypothesis is correct the

[4] Sir WILLIAM THOMSON (Lord Kelvin), *On the division of space with minimum partitional area.* Phil. Mag. **24**: 503–514. 1887.

[5] CECIL H. DESCH, *The solidification of metals from the liquid state.* Jour. Inst. Metals **22**: 241–263. 1919.

grains in a solidified metal should approximate the form of cells of a foam and these, according to Kelvin, should be cuboctahedra[6] with curved edges. Desch experimented with masses of foam and obtained a certain proportion of cells having the cuboctahedral form. By far a greater number, however, had the five sided faces characteristic of the pentagonal dodecahedron. He then proceeded to the examination of the form of the grains in beta brass. This brass containing aluminum was made to separate into its individual grains by immersion in mercury. In this also the majority of faces were five sided and the form of most of the grains seemed to approach the pentagonal dodecahedron.

The writer confirmed the observations of Desch on the cells of a foam. A large mass of fairly uniform bubbles was produced in a closed vessel by slowly blowing air at constant low pressure through a fine capillary tube. By observing the reflections of light from the contact surfaces of the interior of the mass it was found that a considerable majority of the faces were of pentagonal outline and that the cells approximated the form of the regular pentagonal dodecahedron. A much smaller proportion showed four and six sided faces, confirming the presence of Kelvin's cuboctahedral cell. The latter is further confirmed by the practical absence of anything recognizable as a rhombic dodecahedral cell.

Since the problem was considered as one of interfering spheres, a number of equal spherical masses of plastic modeling clay about 1 centimeter in diameter were packed in a spherical space and subjected to, as nearly as possible, equal pressure from all directions. When the masses of clay were separated and examined, the interior units had become polyhedra and a considerable majority of them showed five sided faces.

In packing uniform spheres to fill space there are two extremes of compactness of the group. Thus the loosest packing is six-contact packing, that is, any sphere taken as a nucleus is in contact with six other spheres. Compression of such a group would result in the nuclear sphere assuming a cubic form. On the other hand, the closest possible packing is twelve-contact packing, in which each nucleus of the group is in contact with twelve other spheres. There are three

[6] The term cuboctahedral is here used in preference to tetrakaidecahedral because crystallographers are more familiar with it. It is to be understood that the tetrakaidecahedron of Kelvin is a simple cuboctahedron or octahedron evenly truncated by the faces of the cube so that all edges are of equal length. This yields a fourteen-faced solid in which six of the faces are squares and eight are regular hexagons.

convenient ways in which twelve spheres may be brought into contact with the central sphere. First, six units may be arranged around the circumference in a plane with the nucleus, and a triangular group of three placed above and three below. Crystallographically considered the equatorial spheres would yield faces, if the spheres were forced together, in the position of a hexagonal prism with a trigonal pyramid above and below. This may consequently be referred to as the hexagonal-trigonal packing. The second grouping may be constructed with four spheres placed below the nucleus, four above, and four around the equator. By compression such an aggregate will yield a rhombic dodecahedron and such packing is called rhombic dodecahedral packing. In the third arrangement five spheres form a ring above the equatorial plane of the nucleus and five below, offset so as to occupy the interstices of the upper five. One sphere at the top and one at the bottom completes the group. This group, upon compression, gives a regular pentagonal dodecahedron as the nucleus and may be called pentagonal dodecahedral packing.

The faces formed upon any sphere, considered as a nucleus of a homogeneous group, by continued uniform growth or by compression must obviously obey the law which requires that the planes of contact be at right angles to the lines joining the centers of the spheres. In the case of rigid spherulitic oolites of calcium carbonate, all growing outward at a uniform rate, the form attained must be polyhedral and governed entirely by the initial position of the oolites with reference to one another. Assuming a close packing there would be a twelve-contact arrangement and the resultant polyhedra must be either pentagonal dodecahedra, rhombic dodecahedra or the hexagonal trigonal form mentioned above. The cuboctahedron, the minimal form, could not arise because it would require fourteen point packing of the original spheres, which is impossible.

The pentagonal dodecahedral forms under discussion may then be reasonably interpreted by assuming a pentagonal dodecahedral packing of the oolites in their original resting place. The fact that the pentagonal dodecahedron is the form which actually occurs suggests that the corresponding packing is most easily assumed, a suggestion further supported by the experiment wherein numerous plastic spheres were packed and compressed. To test the suggestion further a large number of ordinary uniform-sized shot were placed in a round bottomed vessel, shaken until settled and cemented with heated wax. Upon dissection of this mass of spheres, the great majority seemed to be packed in pentagonal arrangement. The experiments with

masses of foam, both by Desch and by the writer are also in agreement. There is an essential difference in the behaviour of foams, however, since the spheres of foam are more mobile, are capable of greater movement and deformation and of subdivision, and are more sharply dependent upon surface tension. It is very likely, though, from the large number which approach pentagonal symmetry that the normal packing is pentagonal. The fact that no rhombic dodecahedral foam cells are noted substantiates the ideas of Kelvin, but it is also true that every instance of rhombic dodecahedral twelve-point packing must result in the formation of cuboctahedral cells in a foam. The relative scarcity of cells of this form further argues as to the greater stability of the pentagonal dodecahedral packing. The foam cells behave to a remarkable degree like rigid spheres, even to an appreciable deviation from the theoretical angle of stability demonstrated by Plateau in his study of foam films on a wire framework.

The case of metals especially concerned in the work of Desch is a little harder to understand. The coincidence of the pentagonal structure of the granular metal with that of foam is apparently a substantiation of the Quincke hypothesis. In a homogeneous cooling metal-fusion one would expect the solidification outward from nuclei in a spherical front, and in ideal cases, wherein the temperature was homogeneously distributed, these nuclei might be expected to be very equally spaced. Except by means of the foam hypothesis of Quincke, it is difficult to account for the preference shown for a pentagonal packing.

The calcite oolites examined in the Idaho lot are without doubt selected, ideally perfect examples which may represent the concentration of hundreds or thousands of less perfect or variously bounded individuals. Their form is of extreme interest and it is highly desirable that the locality be visited and a large number of these unusual forms collected as well as studied in place. The explanation of their form above set forth seems the most rational one to fit the facts of the case, but further study of the problem would seem to be highly desirable.

PALEONTOLOGY.—*The generic characters of* Astartella *Hall.*[1] GEORGE H. GIRTY, U. S. Geological Survey. (Communicated by J. B. REESIDE, JR.)

The genus *Astartella* was established by James Hall in 1858. The only species referred to it at that time was *A. vera* which consequently

[1] Published by permission of the Director of the U. S. Geological Survey. Received August 31, 1927.

is the genotype. The original description, which is very brief, runs as follows:

> Shell bivalve, thick, smooth or concentrically furrowed: lunule impressed; ligament external; hinge teeth two in each valve, the anterior tooth of the right valve large and strong, with a longitudinal pit in the summit. Related to *Astarte*.

This diagnosis has, so far as I am aware, never been revised or rewritten up to the present time; yet on attempting to verify it from specimens in my collection I found it far from complete and in some respects inaccurate.

The astartellas are one of the commonest pelecypods of our Pennsylvanian faunas and if we except a few species which appear to be isolated because perhaps they are rare, but which may be brought into close relationship when more is known about them, all the species or at least all the more common species are pretty much alike. In any collection of considerable size several species might be distinguished on selected specimens, all of them, however, connected by other specimens of intermediate character. With the astartellas, then, the question is not whether they represent more than a single genus so much as whether they represent more than a single species. The specimens upon which my observations were made therefore unquestionably belong to Hall's genus. I have identified them with *Astartella concentrica* Conrad although it is by no means certain that Conrad's species and the type species of *Astartella* are not the same. *Astartella concentrica* had been in the literature some fifteen years when *A. vera* was described, but it was cited under the genus *Nuculites* and was evidently unknown to Hall.

Although shells of this type constitute one of the most common of Pennsylvanian pelecypods, they rarely show characters of prime generic importance. If they are not actually broken in that part, the hinge margin is liable to be covered by hard rock. Or, as often happens, thanks to the hinge teeth and perhaps also to the marginal denticles, the two valves occur together so that one of them is concealed by the other. To be sure, the shape of these shells is in a measure characteristic and also the sculpture of widely spaced concentric lamellae, although Hall in the original description does say—I suspect with an eye to the off chance—that the shell is smooth or concentrically furrowed. In further comment upon his diagnosis, the right valve is the only one whose interior was figured by Hall and, if

judgment is permitted from certain expressions used, it was the only one known to him. It seems doubtful, as will be shown later, whether either valve actually does have two "hinge teeth," by which expression it is fairly certain Hall meant cardinal teeth.

The hinge teeth, as just remarked, are rarely to be seen in these shells, but one of the other generic characters, the "external ligament" (or at least its receptacle), is a conspicuous feature in any specimen that is even fairly well preserved. By that designation Hall undoubtedly had in mind a sharply defined bevelled surface behind the beaks which corresponds to a similar though smaller surface anterior to them which Hall calls the "lunule." On most specimens these two structures show no material difference except in size, and when I have had occasion to refer to the posterior one I have called it an escutcheon. The same term was employed by Meek in describing *Astartella newberryi*. It may actually have been a ligamental area as Hall considered it; nevertheless, my specimens seem to show another structure on the interior of the shell which was apparently a place of ligamental attachment, and although this fact, even if established, might not necessarily prove that the external structure did not also function in the ligamental equipment, it would tend to discredit Hall's interpretation.

Hall's description, I believe, was predicated largely if not wholly upon the right valve. In my collection left valves showing the hinge are decidedly more numerous than right valves. They show that this valve was equipped with a single prominent cardinal tooth which had a large, deep pit or socket on the anterior side. On the posterior side the cardinal tooth is confluent with a thickening of the hinge margin or sort of hinge plate from which it rises considerably, but by no means as much or as abruptly as it rises from the deeply excavated socket in front of it. The shell on the anterior side of the socket is as high and prominent as the cardinal tooth itself; it is probably to be considered a lateral tooth, though it is merely the shell margin which as it recedes, forms the broad, sharply defined lunule.

The hinge structure of the right valve, as already noted, is not shown by as many specimens as the left valve, but it is shown very well indeed by one of them. This specimen has a single large wedge-shaped cardinal tooth that is flat on top and slightly indented by two longitudinal grooves. The tooth has a deep triangular socket on the posterior side; on the anterior side it descends vertically, but not quite so far, and is continuous with a narrow shelf-like projection that is carried forward almost to the anterior extremity of the shell.

This, the anterior prolongation of the hinge-plate, is guarded on its outer or upper side by the thin, strongly projecting edge of the escutcheon, and as its inner edge also is elevated, a short groove is inclosed between them.

But little difficulty is experienced in correlating the structures of the two valves. The flat-topped denticle in the right valve evidently fits into the deep pit that is anterior to the cardinal tooth of the left valve, while the cardinal tooth of the left valve is received by the deep pit that is posterior to the cardinal tooth of the right valve. Thus I recognize but a single cardinal tooth in each valve instead of two. Nevertheless, it is possible to harmonize my observations in some measure with those of Hall, for a slight prominence exists posterior to the socket of the right valve where Hall has figured a posterior cardinal tooth. His figure, however, is not accurate; at least it is not in accord with my observations, and I should hardly regard this elevation as being a tooth. The structure in this part is peculiar and will be considered more in detail farther on. Hall's figure shows two other structures that are really important, although, inasmuch as he did not have the left valve to compare them with, he failed to recognize their significance. His figure shows, though not clearly, a groove passing down the anterior side of the shell margin for a short distance. Actually, as has just been described, this margin is thickened into a narrow shelf that extends forward almost to the anterior extremity, and this shelf-like structure bears a groove along its upper surface by reason of its raised margins. Hall's figure also shows quite clearly a projecting lamina back of the beak which is really the margin of the shell along what he calls the ligamental area.

The construction of the left valve is just the reverse of this for the shell is thickened along the posterior margin of the hinge line and grooved to receive the sharp and projecting edge of the right valve, while the shell margin in front of the beak is, as already described, sharp and projecting so as to fit into the groove of the right valve corresponding to it. Whether this reciprocating structure of the two valves would properly be called teeth, I am not sure. In each case one "tooth" seems to be merely the shell margin and not an independent structure comparable to the cardinal teeth.

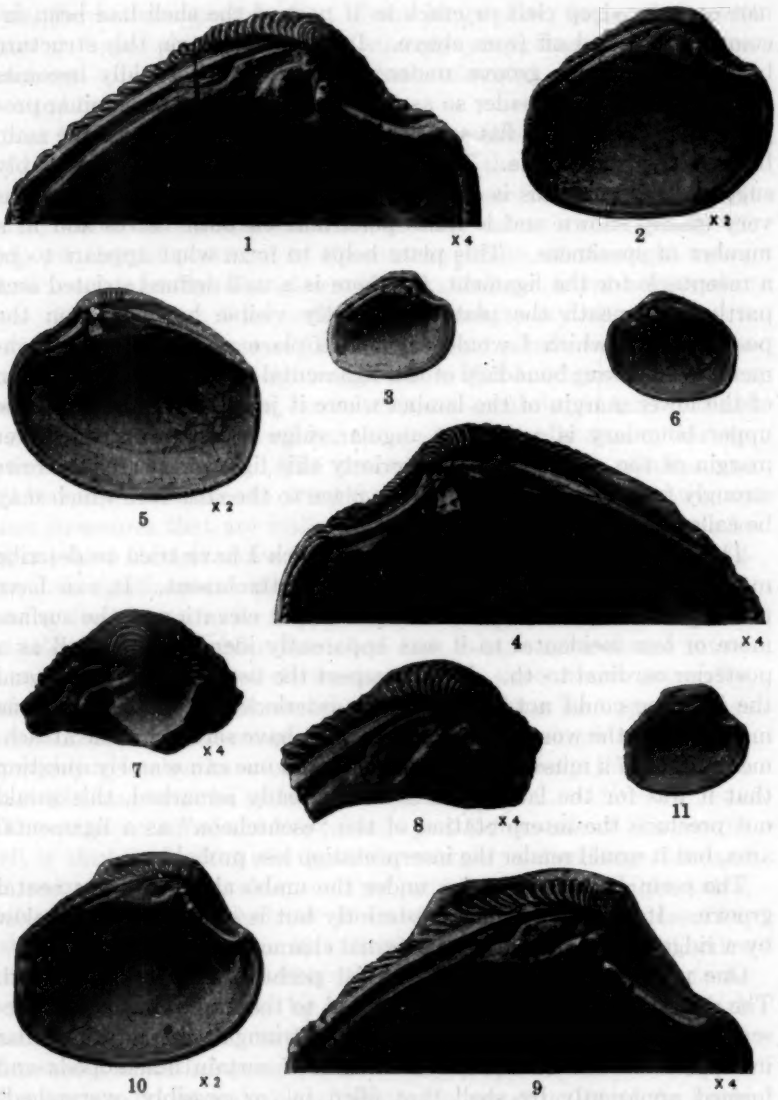
I must now try to make clear the singular construction of the hinge where in the right valve Hall thought he recognized a posterior cardinal tooth. At this point there is constructed a flat-lying plate approximately parallel to the hinge plate proper, but free above and connected with it only at the lower side. This plate incloses a very

narrow, very deep cleft or crack as if part of the shell had been incompletely sawed off from above. In other language, this structure begins as a narrow groove under the beak which rapidly becomes deeper though not broader so as to detach from above a laminar projection that lies almost flat and is but slightly separated from the main body of the hinge plate. To the reader the thought would probably suggest itself that this is some appearance due to accident, but it is very clearly shown and is quite persistent on both valves and in a number of specimens. This plate helps to form what appears to be a receptacle for the ligament, for there is a well-defined striated area partly underneath the plate and partly visible beyond it on the posterior side which I would say was a place of ligamental attachment. The lower boundary of this ligamental area was a continuation of the lower margin of the lamina where it joins the hinge plate; the upper boundary is a distinct angular ridge which forms the lower margin of the escutcheon. Posteriorly this ligamental area narrows strongly from below upward, giving place to the structure which may be called the posterior lateral tooth.

The somewhat remarkable structure which I have tried to describe must, I think, be a place of ligamental attachment. It can have nothing to do with dentition though a slight elevation of the surface more or less incidental to it was apparently identified by Hall as a posterior cardinal tooth. In this respect the two valves are alike and the lamellae could not possibly have interlocked. In so far as one may venture the word, this structure must have served for the attachment either of a muscle or of a ligament, and one can scarcely question that it was for the latter. As I have already remarked, this would not preclude the interpretation of the "escutcheon" as a ligamental area, but it would render the interpretation less probable.

The escutcheon also begins under the umbo above the ligamental groove. It regularly widens posteriorly but is sharply defined below by a ridge and is distinctly an external character.

One more feature, somewhat trivial perhaps, may be mentioned. The dental socket does not itself extend to the umbo, but it is represented upon the plane of the lunule by a triangular structure similar in appearance to the pseudodeltidium of certain brachiopods and formed apparently by shell that filled in (or possibly overarched) the socket as the tooth of the other valve moved forward or was worn off at the upper end. This structure is sharply defined by grooves and is convex, especially on the posterior side. It may be concave on the anterior.



Figures 1–11, *Astartella concentrica* Conrad. 1–3, left valve, ×4, ×2, and ×1. 4–6, right valve, ×4, ×2, and ×1. 7, fragment of a left valve tilted to show the covering of the dental socket and its track, ×4. 8, another fragment of a left valve, ×4. 9–11, left valve, ×4, ×2, and ×1.

Lawrence shale, Iatan and St. Joseph, Missouri.

To summarize the structure of this genus as shown by my specimens, each valve has a single large cardinal tooth, the cardinal tooth of the right valve being anterior to that of the left valve when the two valves were joined. The left valve, consequently, has a deep pit or socket on the anterior side of the tooth, while the right valve has a socket on the posterior side of the tooth. In addition the anterior part of the cardinal margin in the left valve forms a linear tooth that is received by a groove in the thickened anterior margin of the right valve. On the other hand, the posterior part of the cardinal margin in the right valve forms a linear tooth that rests in a groove in the thick posterior margin of the left valve corresponding to it. Between the cardinal tooth and the posterior tooth in each valve is an area of ligamental attachment partly inclosed by a leaflike plate which is continuous below with the main hinge structure. The sharply defined areas on the exterior of the shell are lunule and escutcheon, although the posterior one may have housed a ligament as Hall originally thought.

The muscular imprints consist of a rather large, deep, and sharply defined scar at the anterior extremity of the shell, and another somewhat larger, but less deep and less sharply defined, opposite to it on the posterior superior angle. The pallial line connecting these imprints is indistinct in all the specimens seen, but it appears to be without a sinus, as indeed, has generally been believed. A short distance back of the upper margin of the anterior scar and excavated in the underside of the hinge plate is a small but rather deep pedal scar.

BOTANY.—*New passionflowers from South America and Mexico.*[1] ELLSWORTH P. KILLIP, U. S. National Museum.

In preparing a revision of American Passifloraceae the writer has had the opportunity of examining the collections of several herbaria in the United States and Europe. As this revision will not be ready for publication for some time the new species recently noted are here described in advance. Photographs of the type specimens in other herbaria are deposited in the United States National Herbarium.

Passiflora stellata Moritz, sp. nov.

Stem slender, subtriangular, striate, finely pilosulous; stipules setaceous, 5 mm. long; petioles up to 3 cm. long, biglandular at base of blade, the glands 0.5 mm. long; leaves 4 to 6.5 cm. long, 4 to 8 cm. wide, 3-lobed about

[1] Published by permission of the Acting Secretary of the Smithsonian Institution. Received August 13, 1927.

one-third their length (lobes broadly triangular or triangular-ovate, 2 to 3 cm. wide, acute or obtusish), subtruncate at base, 5-nerved, entire at margin, sparsely and minutely pubescent above, more densely pubescent beneath, membranous; peduncles about 2.5 cm. long; bracts setaceous, scattered; flowers white or greenish (?); sepals oblong, about 2 cm. long, hyaline at margin, cucullate at apex, keeled, the keel terminating in a horn 3 mm. long; petals linear, less than 1 cm. long, obtuse, white, membranous; corona filaments in a single series, liguliform, about 7 mm. long; operculum membranous, 7 mm. high, slightly plicate, erose at margin, white; gynophore slender, striate, slightly swollen at base; stamens very slender, 1 cm. long; ovary ellipsoidal, 6-grooved, glabrous.

Type in the herbarium of the Muséum d'Histoire Naturelle, Paris, collected "in reg. temp. et subfrig.," New Grenada (Venezuela?), in 1852, by M. Moritz (no. 1961). Duplicate in the British Museum.

This is quite distinct from any known species. The shape of the leaves and the presence of glands at the apex of the petioles indicate a relationship with *P. warmingii*. The stipules, however, are setaceous, not foliaceous; the faucial corona consists of a single, not a double, series of filaments; the gynophore is more slender; and the ovary ellipsoidal, not ovoid.

Passiflora quadriflora Killip, sp. nov.

Plant glabrous throughout; stem angular, strongly compressed, striate, scabrous; stipules setaceous, about 1 cm. long; petioles 7 to 9 mm. long, tortuous, glandless; leaves narrowly lanceolate, 5 to 8 cm. long, 1.5 to 2 cm. wide, unlobed, acute, mucronulate, rounded or subcuneate at base, entire, 3-nerved (nerves nearly parallel, conspicuous), reticulate-veined, ocellate between lateral nerves and midnerve, coriaceous or subcoriaceous; peduncles in pairs, 2-flowered, the main portion and the branches nearly equal, each about 1 cm. long; bracts setaceous, 3 to 5 cm. long, scattered; flowers rotate-campanulate, about 5 cm. wide, greenish (?); sepals lanceolate, about 2 cm. long, 0.5 cm. wide at base, acute; petals linear-lanceolate, 5 to 6 mm. long, 1 to 1.2 mm. wide, obtuse, white, membranous; corona filaments in two series, the outer filiform, 5 to 6 mm. long, the inner series capillary, 2 mm. long; operculum membranous, 2 mm. long, slightly plicate, finely fimbriate one-third its length; nectary ring annular; limen shallowly saucer-shaped, 0.5 mm. high; ovary globose; styles very slender, about 8 mm. long.

Type in the herbarium in the Field Museum of Natural History, no. 536227, collected at Villcabamba, hacienda on the Río Chinchao, Peru, altitude about 1900 meters, July 17 to 25, 1923, by J. F. Macbride (no. 5189). A specimen of this collection is also in the U. S. National Herbarium.

This species presents several unusual characters. The peduncles are 2-flowered, but they do not terminate in a tendril as in the case of *P. cirrhiflora*, *P. tryphostemmatoides*, and *P. gracillima*. The leaves are unlobed, an unusual form in the subgenus *Plectostemma*, to which the species clearly belongs. The operculum, in addition, is more conspicuously fimbriate than in most species of this subgenus.

Passiflora goniosperma Killip, sp. nov.

Plant densely pilose-hirsutulous throughout, the hairs of the stem often recurved or retrorse; stem subtriangular, tortuous; stipules linear-lanceolate, 4 to 6 mm. long, up to 1 mm. wide, aristate, subfalcate; petioles 5 mm. long

or less, glandless; leaves oblong in general outline, 2-lobed one-quarter to one-third their length, 1.5 to 4.5 cm. along mid-nerve, 2 to 6 cm. along lateral nerves, 2 to 4 cm. between tips of lobes (lobes obtuse, mucronulate, the sinus truncate or slightly rounded, occasionally emarginate, often mucronulate at end of midnerve), scaberulous and densely hirsute above with subappressed white hairs which are enlarged at base, usually pilose-hirsute and paler beneath; flowers in pairs on short (2 cm.), axillary, leafy branches, rarely on the main stem; bracts none; sepals lanceolate, about 7 mm. long, 2 mm. wide, acute, hirsutulous without; petals narrowly linear, 3 to 4 mm. long, 1 mm. wide; corona filaments in a single series, liguliform, 2 mm. long; operculum membranous, closely plicate, white; limen annular; ovary ovoid, longitudinally 6-grooved, white-puberulent; fruit asymmetrically ellipsoidal, up to 4 cm. long and about 1 cm. wide, sharply 6-angled, long-tapering at ends; seeds obovate, 3 to 4 mm. long, 1.5 to 2 mm. wide, blackish, lustrous, narrowed at both ends, the axis more or less curved, the lateral margins thin-winged, the central portion of each face elevated, forming a sharp-toothed ridge (hence the seed quadrangular in cross-section).

Type in the Universitetets Botaniske Museum, Copenhagen, collected at Niña de Dolores, (Oaxaca?), Mexico, August, 1842, by Frederik Liebmann (no. 4076; *Passiflora* no. 29).

OAXACA: Santa Gertrudis, *Liebmann* 4075, *Passiflora* no. 30 (Copenhagen). Sierra de Ixthlán, *Conzatti* in 1913 (U. S. N. M., Gray Herbarium), in 1918 (Missouri Botanical Garden).

The seeds of *P. goniosperma* differ markedly from those of other American species of *Passiflora*. Each of the two faces has the appearance of being compressed laterally to form a narrow longitudinal ridge; the transverse ridges, normally extending from margin to margin in the species of the subgenus *Plectostemma* with sulcate seeds, are reduced to a row of teeth along this longitudinal ridge. The ellipsoidal, 6-angled fruit, the absence of bracts, and the general aspect of the plant, however, show a rather close relationship with *P. capsularis*, the species to which the type specimen of *P. goniosperma* was referred by Masters. In addition to the seed characters, other marks which distinguish it from *P. capsularis* are the smaller leaves, with rounded subparallel lobes (lobes usually acute, divergent in *P. capsularis*).

Passiflora conzattiana Killip, sp. nov.

Stem slender, terete, pilosulous, becoming glabrate, reddish; stipules setaceous, about 4 mm. long; petioles densely pilosulous, 0.8 to 2 cm. long, glandless; leaves 2 to 5 cm. long, 3 to 8 cm. broad, 2-lobed (lobes acute, rarely obtusish, widely divergent, the sinus shallowly semilunate or the upper margin nearly truncate), entire, cordate at base, 3-nerved (nerves often terminating in a short cusp), thin, sparingly setose above, densely pubescent beneath; peduncles solitary or in pairs, slender, up to 2 cm. long; bracts none; flowers small, 1 to 2 cm. wide; sepals linear-lanceolate, 3-nerved, sparingly pilose without, glabrous within, 8 to 10 mm. long, 2 mm. broad, petals linear-lanceolate, 4 to 5 mm. long, 1.5 mm. broad; corona filaments in a single series, relatively few, liguliform, 3 to 4 mm. long, 0.4 mm. broad, deep red; operculum membranous, erect, closely plicate, red below, pale yellow or white above, the margin minutely fimbrillate; limen annular; gynophore glabrous, 4 to 5 mm. long; anthers oblong, 3 mm. long,

1 mm. broad; ovary narrowly ovoid, densely puberulent or tomentulose; styles clavate, 3 mm. long; stigma globose, 0.8 mm. in diameter; fruit narrowly ellipsoidal, about 5 cm. long (including the long slender stipe and the caudate tip), 1 cm. wide, 6-angled, finely pubescent, at length glabrous; seeds broadly obcordate or suborbicular, 1.5 to 2 mm. long and wide, transversely 5 or 6-grooved, the ridges smooth.

Type in the U. S. National Herbarium, no. 1,206,806, collected at Mirador, Veracruz, Mexico, June, 1921, by C. A. Purpus (no. 8804).

San Luis Potosí: Las Canoas, *Pringle* 3638 (Gray Herbarium).

Veracruz: Near Jalapa, *Rose & Hough* 4260 (U. S. N. M.), 4938 (U. S. N. M.), 7840 (U. S. N. M.). Totula, *Liebmann* 4154, *Passiflora* 28 (Copenhagen).

The principal points of difference between this species and *P. capsularis* and *P. rubra* are much smaller flowers, smaller leaves nearly truncate at the upper margin, nearly orbicular, rather than oblong, seeds. Several of the specimens here cited were distributed as *P. rubra*, a species frequent in the West Indies and South America but apparently not found in Mexico.

Passiflora urbaniana Killip, sp. nov.

Plant scandent, with slender tendrils; stem terete, softly ferruginous-villosulous or almost tomentose toward end; stipules minute, semiannular about stem, barely 0.5 mm. long; petioles 5 to 10 mm. long, slightly dilated at base, glandless, densely ferruginous-tomentose; leaves oblong or lance-oblong, 4.5 to 8 cm. long, 2 to 4 cm. wide, obtuse or rounded at apex, entire or remotely undulate-serrulate, 3- (or 5-)nerved (nerves impressed at base, the lateral not reaching to middle of margin, the secondary nerves 5 to 7 on each side), subcoriaceous, minutely hispidulous above, densely and softly ferruginous-tomentose beneath; peduncles 5 to 8 cm. long, pilosulous; bracts 2 to 2.5 cm. long, 1 to 1.5 cm. wide, viscous, deeply bipinnatisect, the segments gland-tipped; flowers about 5 cm. wide, the tube short-campanulate, hirsutulous without; sepals oblong, about 2 cm. long, 0.6 cm. wide, obtuse, greenish and hirsutulous without, 3-nerved, the middle nerve becoming carinate toward apex, and terminating in a short horn; petals linear, slightly shorter than the sepals, lavender; corona filaments in 5 series, those of the two outer filiform, about 1.3 cm. long, violet at base, radiate, those of the inner series almost capillary, about 2 mm. long, erect; operculum membranous, erect, about 1 mm. high, non-plicate, minutely denticulate; limen similar to operculum, about 2 mm. high; ovary subglobose, densely white-villous-tomentose.

Type in the U. S. National Herbarium, no. 529493, collected at Sanitago de las Vegas, Province of Havana, Cuba, where cultivated, May, 1906. (Herbarium de Cuba, Estación Central Agronómica no. 2588.) Said to have been grown from seeds from Belize, British Honduras. Specimens of this collection have been seen in the New York Botanical Garden, the Gray Herbarium, and the Berlin Botanical Garden.

This is a most unusual species, and it is unfortunate that its precise origin is uncertain. The bracts and flower structure show that it belongs to the subgenus *Dysosmia*, of which the only other species with entire oblong leaves is the Brazilian *P. clathrata*. That is an erect, suffrutescent plant with very short peduncles and a wholly different indument. The leaves

are very similar in shape and size to those of *P. multiflora*, a native of the West Indies, belonging to a wholly different group of *Passiflora*. There is a bare possibility that this may be a hybrid of *P. multiflora* and some species of the *Dysosmia* group, perhaps *P. foetida*.

This new species is named for Dr. I. Urban, the eminent student of the flora of the West Indies, whose assistance to me at Berlin is highly appreciated.

Passiflora mesadenia Killip, sp. nov.

Stem subquandrangular, striate, pilosulous; stipules subreniform, 1.5 to 2 cm. long, 0.5 to 0.8 cm. wide, aristate, glandular-dentate near base; petioles up to 2 cm. long, 2 or 3-glandular at middle, the glands short-stipitate, about 2 mm. long and 1 mm. in diameter; leaves 4 to 6 cm. long, 6 to 8 cm. wide, 3-lobed to middle (lobes acute, the middle lobe oblong-lanceolate, the lateral lobes ovate-lanceolate), subauriculate at base (basal lobes slightly overlapping), shallowly and irregularly dentate-serrate, 5-nerved, reticulate-veined (nerves and veins impressed above), subcoriaceous, dark green and glabrous above, paler and pilosulous on the nerves and veins beneath; peduncles solitary, up to 5 cm. long, subquadrangular, stout; bracts 4 to 5 cm. long, acute, united about half their length, glabrous; flower-tube cylindric, 7 to 8 cm. long, about 1 cm. in diameter, pink without, glabrous; sepals oblong, about 4 cm. long, 1 cm. wide, obtuse, concave toward apex, short-awned on outside just below apex, pink without, white within; petals oblong-spatulate, as long as the sepals, about 1.5 cm. wide, obtuse, white; corona reduced to a row of small thick tubercles about 1 mm. long; operculum 5 to 6 mm. long, the margin recurved, denticulate; limen closely surrounding base of gynophore, lobulate; ovary narrowly ovoid, glabrous, pruinose.

Type in the herbarium of the Field Museum of Natural History, no. 536001, collected at Villcabamba, hacienda on the Río Chinchao, Peru, altitude about 1800 meters, July 17–26, 1923, by J. F. Macbride (no. 4960).

This species differs from *P. macrochlamys*, a near relative, in the conspicuous petiolar glands, borne near the middle of the petiole, auriculate leaf-bases, much smaller stipules, and longer flower tubes.

Passiflora roseorum Killip, sp. nov.

Stem angular, striate, densely tomentulous; stipules oblong, 1.5 cm. long, 8 to 9 mm. wide, oblique and subcordate at base, fimbriate-dentate, the teeth 2 to 3 mm. long, not gland-tipped; petioles up to 1.5 cm. long, bearing 2 or 3 rudimentary glands, or glandless; leaves 3.5 to 4 cm. long, 4.5 to 5 cm. wide, 3-lobed (lobes triangular-ovate or suborbicular, 1.5 to 2 cm. wide, rounded at apex, the angle at sinus between middle and lateral lobes about 90°), truncate at base, 5-nerved, glandular-serrulate, thick-coriaceous, glabrous and sublustrous above, densely brown-tomentose beneath, the nerves and veins impressed above; peduncles up to 5 cm. long; bracts 4 cm. long, united two-thirds their length (free portions ovate-lanceolate, about 1.5 cm. wide, abruptly acuminate), puberulent without, tomentose within; flowers violet, the tube cylindric, 7 to 8 cm. long; sepals oblong, about 3 cm. long, 1.5 cm. wide, obtuse, minutely awned on outside just below apex; petals subequaling the sepals, obtuse; corona reduced to a deeply crenulate ring, scarcely tuberculate; operculum dependent, the margin recurved, subentire; gynophore slender, not exserted; ovary obovoid, glabrous.

Type in the U. S. National Herbarium, no. 1,022,682, collected in the vicinity of Zaragura, Ecuador, September 28, 1918, by J. N. Rose, A. Pachano, and George Rose (no. 23154).

This may be a hybrid between *P. jamesoni* and *P. ecuadorica*, the fringed stipules suggesting the former and the small, shallowly lobed leaves the latter. Unlike either of these the under surfaces of the leaves and the involucre are covered with a dense brownish tomentum.

Passiflora anastomosans (Lam.) Killip.

Tacsonia anastomosans Lam. in DC. Prodr. **3**: 335. 1828.

Passiflora acutissima Killip.

Tacsonia lanceolata Mast. in Mart. Fl. Bras. **13**[1]: 536. 1872.
Passiflora lanceolata Harms, Bot. Jahrb. Engler **18**: Beibl. **46**: 11. 1894, not *Passiflora lanceolata* G. Don (1834).

Passiflora matthewsii (Mast.) Killip.

Tacsonia matthewsii Mast. in Mart. Fl. Bras. **13**[1]: 539. 1872.

Passiflora urceolata (Mast.) Killip.

Tacsonia urceolata Mast. in Mart. Fl. Bras. **13**[1]: 539. 1872.

Passiflora paulensis Killip, sp. nov.

Plant glabrous throughout; stem terete, striate; stipules subreniform, 0.7 to 1.5 cm. long, 2 to 2.5 cm. wide, cuspidate, crenulate to subentire, membranous; petioles slender, up to 2 cm. long, 2 to 4-glandular, the glands stipitate, up to 1 mm. long; leaves ovate-oblong or oblong-lanceolate, 5 to 7 cm. long, 3 to 4 cm. wide, acute, rounded and subpeltate at base, entire, subtripli- or quintuplinerved, arcuate-veined, membranous; peduncles slender, up to 3.5 cm. long; bracts cordate-ovate, 2 to 2.5 cm. long, 1 to 1.5 cm. wide, acute, conspicuously reticulate-veined, chartaceous, pinkish when dry; flower-tube broadly campanulate, ventricose at base; sepals oblong, about 2.5 cm. long, 1 cm. wide, obtuse, cucullate; petals oblong-spatulate, slightly longer than sepals, obtuse; corona filaments in 5 series, the two outer 2 to 2.5 cm. long, terete, fasciate, those of the two succeeding series minute, about 1.5 mm. long, the inner series about 2 mm. distant, membranous at base, filamentose on margin, the filaments 2 mm. long; operculum membranous, horizontally spreading, serrulate at margin; limen cylindric, 7 mm. high, the lower two-thirds adnate to gynophore, the upper third flaring outward; ovary subglobose, glabrous.

Type in the herbarium of the Muséum d'Histoire Naturelle, Paris, collected at Apiahy, São Paulo, Brazil, in 1883, by Puiggari.

Although numerous species have been described in this group of the subgenus *Granadilla* with entire leaves and foliaceous stipules and bracts, none of these descriptions apparently apply to this plant. The material examined at Berlin was distributed as *P. subrotunda*, which appears to be only a small-leaved form of *P. mucronata*. From *P. mucronata*, *P. paulensis* differs in the shape of the bracts, which are borne close to the flower, more slender petioles, leaves of a much thinner texture, and in the arrangement of the corona.

Passiflora dalechampioides Killip, sp. nov.

Plant glabrous throughout; stipules semi-oblong, 1.5 to 3.5 cm. long, 0.7 to 1.5 cm. wide, acute, mucronulate, rounded at base, oblique, attached laterally near base; petioles 2 to 3.5 cm. long, bearing 6 to 9 short-stipitate glands on dorsal side; leaves trisect to within 2 mm. of base (segments lanceolate or elliptic-lanceolate, 3.5 to 10 cm. long, 1 to 3.5 cm. wide, acuminate, mucronulate, glandular-serrulate in sinuses, often overlapping), cordate at base, 3 or 5-nerved, reticulate-veined, subcoriaceous, sublustrous; peduncles 3.5 to 10 cm. long, articulate just below apex; bracts oblong or oblong-lanceolate, 1 to 1.2 cm. long, 0.5 to 0.6 cm. wide, acute, mucronulate, thin-membranous, glaucous, borne at point of articulation; flowers about 4.5 cm. wide, "greenish blue," the tube short-campanulate; sepals linear-oblong, about 2 cm. long, 0.6 to 0.8 cm. wide, cucullate and short-awned at apex; petals linear, about 1 cm. long, 0.3 cm. wide; corona filaments in 3 series, the outermost filiform, about 7 mm. long, the two inner capillary, 2 to 3 mm. long; operculum membranous, 2 mm. high, denticulate; nectar ring a short membrane; limen tubular, adnate to base of gynophore; ovary ovoid; fruit ovoid, 4 cm. long, 2 cm. wide (probably larger), the exocarp coriaceous; seeds obovate-oblong, about 5 mm. long, 3 mm. wide, reticulate.

Type in the U. S. National Herbarium, no. 943534, collected at Coroico, Yungas, Bolivia, in September, 1894, by M. Bang (no. 2441). Duplicates in the herbarium of the New York Botanical Garden and in the Gray Herbarium.

This collection was identified by Masters as *P. trisulca*. The leaves bear a general resemblance to that species, though they are much more deeply lobed, and the petiolar glands are more numerous. The flowers are smaller, the outer corona filaments filiform, not liguliform, and the operculum merely denticulate. The shape of the leaves suggests rather *P. weberbaueri*, a wholly different species of the subgenus *Granadillastrum*.

Passiflora rubrotincta Killip, sp. nov.

Plant glabrous throughout; stem terete, wiry, drying yellowish; stipules subreniform, 1.5 to 2 cm. long, 0.5 to 0.8 cm. wide, minutely mucronulate at one end, rounded at other, remotely crenulate or subentire, coriaceous; petioles about 2 cm. long, glandless; leaves 4.5 to 8 cm. long and wide, angulately 3-lobed (middle lobe ovate-deltoid, 3 to 4 cm. long, 4 to 5 cm. wide at base, obtusish, the lateral lobes less than half as long), distinctly peltate, truncate at lower margin, 5-nerved, coriaceous, dark green and lustrous above, dull and reddish beneath; peduncles 4 to 7 cm. long, slender, articulate about 2 mm. from apex; bracts cordate-ovate, about 1 cm. long, 0.7 cm. wide, acute, mucronulate, reddish; flowers 4 to 5 cm. wide, the tube campanulate; sepals oblong-lanceolate, about 5 mm. wide at base, coriaceous, dorsally awned just below apex, the awn foliaceous, about 1 cm. long; petals linear-spatulate, slightly shorter and narrower than the sepals; corona filaments filiform, in 3 (or 4?) series, the inner barely 2.5 mm. long; operculum membranous and non-plicate below, filamentose above, the filaments about 3 mm. long; limen tubular, closely surrounding base of gynophore; ovary ovoid.

Type in the herbarium of the New York Botanical Garden, collected in Bolivia, the precise locality not stated, by M. Bang (without number).

The angularly lobed, distinctly peltate leaves at once differentiate this species from relatives of the subgenus *Granadilla*.

Passiflora tenuifila Killip, sp. nov.

Plant glabrous throughout; stem terete or the younger parts subangular; stipules semi-oblong or subreniform, 1 to 4 cm. long, 0.5 to 2 cm. wide, obtuse or acutish, mucronulate at apex, rounded at base, subentire, glaucescent beneath; petioles 2 to 5 cm. long (lower up to 8 cm.), 2 to 5-glandular, the glands up to 2 mm. long, thickened at base, scattered or subopposite; leaves 3.5 to 8 cm. along midnerve, 3 to 7 cm. along lateral nerves, 5 to 12 cm. between apices of lateral lobes, 3-lobed two-thirds to three-quarters their length (lobes oblong or obovate-oblong, 1 to 3.5 cm. wide, rounded or obtuse, mucronulate at base, glandular-serrulate in the acutish sinuses, the middle lobe narrowed at base), cordate, 5-nerved, subpeltate, membranous, glaucescent beneath; peduncles 3 to 8 cm. long, slender, articulate less than 2 mm. from apex; bracts cordate-ovate, 1 to 1.5 cm. long, 0.6 to 1.2 cm. wide, abruptly acute and mucronate at apex, glandular-serrulate at base, glaucous, borne at point of articulation, persistent; flowers up to 3.5 cm. wide, the tube patelliform, introrse at base; sepals narrowly oblong, 5 to 7 mm. wide, obtuse, carinate, bright green along the keel, white at margin, the keel terminating in a foliaceous awn 4 to 6 mm. long; petals about two-thirds as long and as broad as sepals, obtuse, white; corona filaments very slender, almost capillary, in 4 series, the outer two 5 to 7 mm. long, radiate, the inner two 1.5 to 2.5 mm. long; operculum membranous, 1 mm. high, slightly plicate at margin, filamentose, the filaments attached dorsally just below margin, 1 to 1.5 mm. long; nectar ring a low fleshy ridge; limen shallowly cupuliform, loosely surrounding base of gynophore; ovary ovoid, glaucescent.

Type in the U. S. National Herbarium, no. 1,232,864, collected at Marechal Mallet, Paraná, Brazil, about 800 meters altitude, January 2, 1904, by P. Dusén. A duplicate of this collection is in the Gray Herbarium.

BRAZIL: Ijuhy, Rio Grande do Sul, *Lindman* 1363 (U. S. N. M.).

PARAGUAY: Along Upper Paraná River, *Fiebrig* 6230 (U. S. N. M., Gray).

This material was distributed as *P. coerulea* and *P. tucumanensis*. The species is not even closely related to *P. coerulea*, differing greatly in leaf shape and flower structure. Though belonging to the complex group of granadillas with 3-lobed leaves and foliaceous stipules, it is at once distinguished by small flowers with very short, almost capillary corona rays. *Passiflora tucumanensis*, *P. naviculata*, and *P. giberti* in general appearance closely resemble *P. tenuifila*, but, in addition to larger flowers with coarser corona rays, the first two have glandless petioles, and the third has a distinctly plicate operculum.

Passiflora phaeocaula Killip, sp. nov.

Plant scandent, the tendrils well-developed; stem subquadrangular, slender, dark purple; stipules setaceous, soon deciduous; petioles 5 to 8 mm. long, glandless or obscurely glandular at base of leaf, minutely puberulent; leaves oval, 3.5 to 5 cm. long, 2 to 2.5 cm. wide, rounded and slightly emarginate at apex, rounded at base, entire, penninerved (lateral nerves 5 to 7 to a side), reticulate-veined (nerves and veins elevated and conspicuous on

both surfaces), thick-coriaceous, lustrous and glabrous above, dull and minutely puberulent beneath; peduncles solitary in axils, 1-flowered, 4 to 6 mm. long, shorter than the adjacent petiole; bracts soon deciduous; flower tube funnel-shaped, about 8 mm. long, 5 mm. wide at throat, dark-maculate within; sepals narrowly oblong, about 2 cm. long, 0.6 cm. wide, obtuse, ecorniculate; petals similar and subequal to sepals; corona filaments in 2 series, the outer about 1 cm. long, subdolabriform, linear below, dilated to width of about 1.5 mm. above middle, attenuate at tip, the inner filiform, about 1.5 mm. long, shallowly bifid; operculum borne in lower third of tube, erect, 4 mm. long, filamentose nearly to base; ovary ovoid, puberulent.

Type in the herbarium of the New York Botanical Garden, collected along the Upper Rio Negro, Brazil, in 1907 or 1908, by Weiss and Schmidt.

Among species of the section *Pseudoastrophea* this is most readily recognized by the small, very thick leaves with a conspicuous much-elevated reticulate venation. The peduncles are shorter than the petioles, in this respect resembling only *P. candida*. In both series the corona filaments are much fewer than in *P. candida*, *P. haematostigma*, and other relatives, and the outer filaments are essentially entire at the margin of the dilated portion.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

ENTOMOLOGICAL SOCIETY

392ND MEETING

The 392nd regular meeting was held April 7, 1927, in the U. S. Department of Agriculture Motion Picture Laboratory, 1363 C. Street S. W. President J. A. HYSLOP presided. There were present 23 members and 15 visitors.

Mr. FLOYD F. SMITH, of Willow Grove, Penn., was elected to membership.

Program: W. H. LARRIMER: *The control campaign against the European corn borer.* (Illustrated by two motion picture films of the Department entitled "The corn borer and what to do about it," and "Corn and the borer," —and also by several lantern slides dealing with the various phases of the corn borer activities, such as copies of the original $10,000,000 authorization and appropriation bills, organization charts for the campaign, portraits of some of the executive personnel.) In addition to data in explanation of the film and the slides the speaker gave a brief outline of the events of the past few months concerning the corn-borer clean-up campaign, with not only emphasis on the scope and magnitude of the enterprise, but also with emphasis on its experimental character, as being solely an effort to check the spread of the pest, and with no attempt at absolute extermination of it, the experimental character of the campaign being clearly realized and understood not only by the President, the Director of the Bureau of The Budget, and the Congressional Committee, but also by the International Corn-Borer Committee, some of the members of which were most active in obtaining the ten million dollar appropriation.

A. C. BAKER: *The citrus white fly in California.* The speaker gave a brief account of the campaign against this pest and his visit to that State in

this connection. He pointed out that a previous attempt had been made to eradicate the white-fly, which, probably due to a lack of knowledge of its host plants, was unsuccessful. The present campaign resolved itself for this same reason into one of treating the entire infested area, in the hope of reducing the white-fly population to a point where danger of its transfer to the southern citrus region would be minimized, and if possible to a point where eradication might be considered feasible.

Informal remarks were made on request by T. H. COLEBROOK TAYLOR, who has been working on cocoanut insects in the Fiji Islands, and who was en route to his old home in England on a vacation. He gave a brief outline of his work and experiences in the South Seas, and discussed with some detail his researches on the life history and control of *Levuana iridescens* Bath-Baker, a serious pest of cocoanuts in Fiji. This injury, commonly known as "Browning disease," was first noticed by explorers in 1860, and again was recorded in 1907. By 1923 it had spread to about a hundred of the near-by islands. Considerable time in control work was given to spraying experiments with lead arsenate paste and sea water, but much difficulty was experienced in spraying because of the great height, 90 feet or more, of the cocoanut trees, and because of the corrosive qualities of the sea water on the spraying equipment. Search was made in a number of the other countries for parasites, and, at last, in Java, a Tachinid, *Ptychomyia remota* Aldrich, was found. Serious difficulties were encountered in actual transportation by steamer of the parasites because of inadequate facilities, lack of ice, etc., for properly taking care of them. Much of the rearing work, too, was done under highly adverse conditions. He also touched briefly upon explorations made in other places, notably those in New Guinea and the Solomon Islands.

Dr. BÖVING directed attention to two copies of a Danish entomological Magazine, "Entomologiske Meddelelser," vol. 15, Nos. 5 and 6, 1926, which contained an article entitled "The History of Danish Entomology" by Kai L. Henricksen, stating that it presented a very excellent rêsumê of the subject and that there was included a number of good portraits of the outstanding leaders of the work in that country, and natives who in other countries have been identified with entomological work.

Mr. ROHWER directed attention to an old paper by Fabricius written in 1774 in which the author had recorded a thought quite similar to that expressed recently in an address by Dr. Howard that if we only had closer acquaintance with and more intimate knowledge of insects we could better learn to control them.

J. S. WADE, *Recording Secretary.*